KOKAI PATENT APPLICATION NO. HEI 8[1996]-15527

SIDE-EMITTING PLASTIC OPTICAL FIBER AND MANUFACTURING METHOD THEREOF

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SIDE-EMITTING PLASTIC OPTICAL FIBER AND MANUFACTURING METHOD THEREOF

[Sokumenhakkogata purasuchik faibaa oyobi sonoseizohoho]

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[There are no amendments to this patent.]

(54) [Title of the invention]

Side-emitting plastic optical fiber and manufacturing method method thereof

(57) [Abstract]

[Objective] The objective of the present invention is to produce an inexpensive and highly reliable side-emitting plastic optical fiber with a simple structure using a simple method.

[Constitution] In a plastic optical fiber with a core material comprised of a plastic resin, and a cladding material comprised of a fluororesin, a rough surface is provided at the interface between the core material and the cladding material; thus, the reflection of light at the interface between the core material and cladding material is partially changed, and light leaks from the surface of the cladding member, that is, from the sides of the fiber.

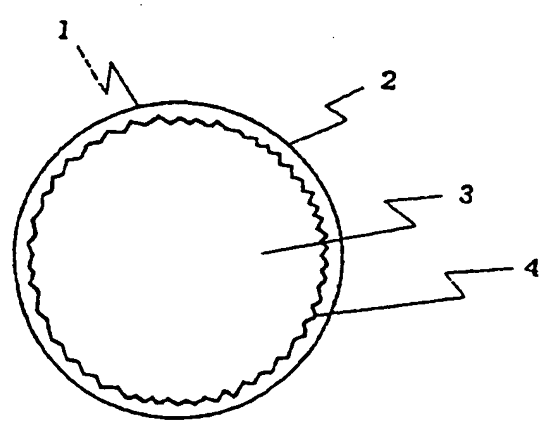
[Explanation of codes] [*Trans. note: copied from p. 3 of original*]

1: Main unit of plastic optical fiber

2: Cladding

3: Core

4: Interface (having roughed surface)



[Claims of the invention]

[Claim 1] A plastic optical fiber having a core material comprised of a plastic resin, and a cladding material comprised of a fluoro-resin, for which the surface of the interface between the core material and the cladding material is made rough.

[Claim 2] The side-emitting plastic optical fiber specified in claim 1 above wherein the above-mentioned rough-surface has a center line average height in the range of 0.1~10 μm, and a maximum height in the range of 0.05~8 μm based on the surface roughness measurement defined by JISB0601.

[Claim 3] The side-emitting plastic optical fiber specified in claim 1 or claim 2 wherein the outer diameter of the optical fiber itself is in the range of 2~15 mm, and the thickness of the cladding material is in the range of 0.2~1.5 mm.

[Claim 4] The side-emitting plastic optical fiber specified in one of claims 1 through 3 wherein a tetrafluoroethylene-perfluoroalkyl vinyl ether copolymer (PFA) or tetrafluoroethylene-hexafluoropropylene copolymer (FEP) is used as the cladding material.

[Claim 5] A method of manufacturing a side-emitting plastic optical fiber consisting of injecting a thermosetting resin as a core material inside a tube-like cladding material having a rough inner surface, and providing a thermosetting process.

[Claim 6] A method of manufacturing the side-emitting plastic optical fiber where the cladding material is produced by the extrusion molding method and the rough-surface inside the cladding material is formed at the same time.

[Detailed explanation of the invention]

[0001]

[Industrial application field] The present invention pertains to the production of side-emitting plastic optical fiber suitable for decorative light, guide light, etc.

[0002]

[Prior art] In recent years, optical fibers have been widely used for a variety of purposes, and in particular, the demand for plastic optical fibers as a means to transmit power where the light itself is transmitted, as well as transmission of signals, is increasing because of the good properties of plastic optical fibers such as large numerical aperture and high flexibility. Among the applications for plastic optical fibers, the use of side-emitting plastic optical fibers for decorative lighting at night is a promising product use, as is guide lighting for subways.

[0003] In conventional side-emitting plastic optical fibers, the cladding material is processed or a special material is mixed with the cladding material so as to leak light from the sides of the optical fiber itself, and the refractive index is changed so that the light that enters the core material is leaked from the sides.

[0004]

[Problems to be solved by the invention] Among the above-mentioned conventional methods, in the former method, a post-process is required after production of the optical fiber itself, and productivity is low. On the other hand, with the latter method, impurities are mixed with the core material; thus, the purity of the material is lost, and performance of the optical fiber itself is reduced and reliability is reduced.

[0005] Based on the background above, the objective of the present invention is to produce an inexpensive and highly reliable side-emitting plastic optical fiber having a simple structure using a simple method.

[0006]

[Means to solve the problem, and effect] In side-emitting plastic optical fibers produced by the method of the present invention, in a plastic optical fiber with a core material made of a plastic resin, and a cladding material made of a fluorine resin, a rough surface is provided at the interface between the core material and the cladding material through which the reflection of the light at the interface between the core material and cladding material is partially changed, and light is leaked from the sides of the fiber cladding material.

[0007] The degree of surface roughness is adjusted according to the luminous energy and the application. The reason is that the greater the leakage of light, the higher the attenuation, and as a result, transmission over a long distance is difficult. Preferably the above-mentioned surface roughness has a center-line average height in the range of 0.1~10 μm, and a maximum height in the range of 0.05~8 μm based the surface roughness measurement defined by JISB0601. When the above-mentioned values based on the JIS standard are below the specified range, the reflection of light is too high, and side emission cannot be achieved; on the other hand, when the said value is greater than the stated range, diffusion is too high, and light does not pass through the fiber, and the fiber is not practical.

[0008] It is desirable to use tetrafluoroethylene-perfluoroalkyl vinyl ether copolymer (PFA) or tetrafluoroethylene-hexafluoropropylene copolymer (FEP) as the cladding material. In the case of a relatively short distance of 10 m or less, PFA is suitable, and in the case of longer distances, FEP is suitable. The reason is because turbidity of the PFA itself, and the surface roughness is suitable for leakage of light, but the attenuation is high, and FEP has properties opposite to those of FPA.

[0009] It should be noted that the dimension of the cladding material is determined according to the flexibility required for bend radius, etc., and an outer diameter of the fiber in the range of 2~15 mm, and a film thickness of cladding material in the range of 0.2~1.5 mm is desirable. When the fiber diameter is 2 mm or less, the absolute magnitude of transmission becomes inadequate and it is not practical; on the other hand, when it exceeds 15 mm, the flexibility is lost; furthermore, the amount of the material used is increased, thus, the cost is also increased. Also, when the thickness of the cladding material is 0.2 mm or less, the mechanical strength is insufficient and can result in rupturing. On the other hand, when the thickness exceeds 15 mm, the flexibility is lost because of the fluororesin used, and wiring is difficult. The manufacturing method of the side-emitting plastic optical fiber of the present invention consists of injecting a thermosetting resin as the core material inside a tube-like cladding material having a rough inner surface, and providing a thermosetting process. In this case, the cladding material is produced by extrusion molding, and the rough-surface is provided at time the cladding material is produced. When the above-mentioned manufacturing method is used, the post processing or mixing of impurities conventionally used is not required, and production is easily accomplished. Furthermore, adjustment of the degree of surface roughness is possible through adjustment of the extrusion molding conditions, and when a thermosetting resin is used for the core material, the cladding material is first made into a tube, and the thermosetting resin then is injected into the tube, and when a thermosetting process is provided, good adhesion between the core and clad can be achieved, and attenuation of light can be prevented when bending stress, etc., is applied to the optical fiber.

[0010]

[Application Example] Fig. 1 shows the end cross section view of a suitable side-emitting plastic optical fiber of the present invention, and Fig. 2 shows an example of the application of said fiber. In the figures, 1 is the plastic optical fiber main unit, 2 is the cladding, 3 is the core, and 4 is the interface between the core and the cladding which has a rough-surface. In Fig. 1, the state of the rough-surface is exaggerated for emphasis.

[0011] When light is transmitted from one end of side-emitting plastic optical fiber 1 produced as described above, leakage of light occurs from the sides of the optical fiber main unit as shown in Fig. 2, and light is emitted.

[0012] Fig. 3 shows the application state of a different example of side-emitting plastic optical fiber of the present invention. In this application example, a rough-surface is formed in certain regions of optical fiber main unit 1 in the longitudinal direction. In the above-mentioned example, leakage of the light is limited to the rough-surface.

[0013] Also, when a mirror and condenser are installed at the end of the optical fiber main unit so that light from the light source can be efficiently transmitted to the fiber main unit, and, at the same time, a mirror is attached to the other end of the optical fiber, uniform emission can be achieved in the longitudinal direction. Furthermore, light sources may be installed at both ends of the optical fiber main unit. As described above, a wide range of lighting at high luminosity can be achieved; thus, applications in areas where many light sources were required in the past is possible, and maintenance and inspection of the light source and wiring is easy.

[0014]

[Effect of the invention] As explained above, with the side-emitting plastic optical fiber of the present invention, side emission is made possible by means of a rough surface at the interface between the core and the cladding; thus, post processes are not required, and the complexity of the production process can be reduced, which leads to a reduction in production costs. Furthermore, mixing excess material for the cladding material is not required, and a pure fluororesin can be used, as a result, a highly reliable product with good environmental effect can be produced.

[Brief explanation of the figures]

[Fig. 1] The figure shows the horizontal explanatory view of the side-emitting plastic optical fiber of the present invention.

[Fig. 2] The figure shows the application of the side-emitting plastic optical fiber of the present invention.

[Fig. 3] The figure shows a different example of the application of the present invention.

[Explanation of codes]

1: Plastic optical fiber main unit

2: Cladding

3: Core

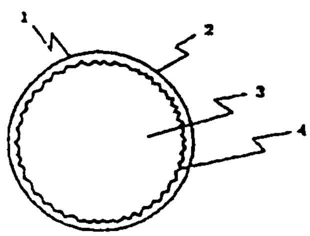
4: Interface (rough surfaced state)

5: Light source

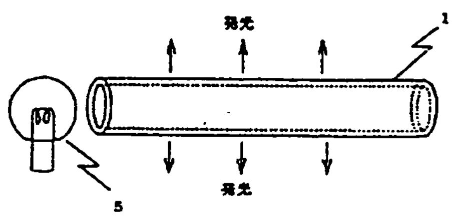
6: Rough-surface interface

→ : Light emission

[Fig 1]



[Fig. 2]



[Fig. 3]